

Wine, forests and smoke: Land users living in harmony

Diana Fisher¹, Kristen Kennison² and Glynn Ward³

¹ Department of Agriculture and Food Western Australia, Locked Bag 7, Manjimup WA 6258

² Department of Agriculture and Food Western Australia, PO Box 1231, Bunbury WA 6230

³ Department of Agriculture and Food Western Australia, Locked Bag 4, Bentley Delivery Centre WA 6983
E-mail: diana.fisher@agric.wa.gov.au

Introduction

The south west of Western Australia is depicted by tall trees, rolling green hills and farm land that supports a diverse array of land uses and social values. For people visiting the region the presence of a vineyard near a forest can be a tranquil and highly appealing experience. However the wine grape and the forest industries have a land use conflict due to the impact of smoke on wine which they are working to resolve.

Smoke is generated from wildfires and planned burning on public and private lands. Grapevines exposed to smoke during sensitive periods of development may produce wine that exhibits smoke-like aromas and flavours and be unfit for purpose. Smoke affected grapes have a negative financial impact on the wine grape industry. The effect of smoke on grapes and wine and the resultant land use conflict is an emerging issue in many fire prone wine growing regions of the world including the south west of Western Australia.

Through scientific research, the impact of smoke on wine grapes has become better understood. These research findings have enabled the wine grape and the forest industries to meet and discuss their concerns and work towards an amicable solution.

Why forests and grapevines are adjacent to each other

Historically, the south west of WA was covered in native vegetation with the majority of the tall trees being Eucalyptus species. Post World War I the Group Settlement Scheme was introduced to the south west. The scheme was designed to increase the population in the sparsely settled rural areas. Groups of migrants were settled on rural blocks and were provided with equipment and funds to establish farms. This meant that native vegetation including the tall trees was removed on the blocks to be farmed. Although the scheme did not meet its original aims it successfully opened up many areas in the south west of WA which are being farmed today. Many of these farms now grow grapevines adjacent to the remaining forests.

Generation of smoke

Smoke is generated annually in the south west of WA from three main sources: wildfires, prescribed burning on public lands and burn-offs on private lands.

Wildfires

Wildfires are unplanned fires, also referred to as bushfires. The highest proportion of wildfires, averaged for the period 2005/06 to 2007/08, is deliberately/illegally lit (45.3%). Wildfires also occur from natural causes such as lightning (24.7%), escapes from burning on public lands (1%) and other burning including private lands (6%), accidental fires by the timber industry (0.3%), other industries (4.3%) and recreationists (5.0%) or are of unknown origin/causes (13.0%) (Government of Western Australia 2008). The earth's warming climate is expected to increase the incidence and severity of wildfires.

Prescribed burning on Department of Environment and Conservation managed lands

Prescribed burning in forests, parks and reserves is undertaken to protect human life, community and natural assets and to conserve biodiversity. Prescribed burning is the most effective and safe way of mitigating the effects of damaging summer wildfires.

The Department of Environment and Conservation (DEC) currently manages approximately 2.4 million hectares of land in the south west. DEC has a statutory responsibility under the *Conservation and Land Management Act 1984* for land management and conserving the state's biodiversity that necessitates prescribed burning. Prescribed burning by DEC is also necessary for hazard management as provided in the *Bush Fires Act 1954* and to meet duty-of-care obligations to DEC staff, neighbours and visitors to DEC managed lands.

Burning by DEC is undertaken on a range of scales (whole-of-forest, landscape, local) and is used to conserve biodiversity through variable fire regimes (season, intensity, inter-fire period), and to protect human lives, infrastructure and built and natural assets.

Since the introduction of broad scale prescribed burning in the mid-1960s, the south west of Western Australia has been protected from large damaging summer wildfires, such as those that have been experienced in Victoria, New South Wales and South Australia and in the United States, Greece and Spain.

The forest of the south west are classed broadly into the dry sclerophyll jarrah (*Eucalyptus marginata*) dominated forests and the wet sclerophyll karri (*E. diversicolor*) dominated forests. There are also timber plantations on public and private lands. The majority of these are pines (*Pinus radiata* and *P. pinaster*) and Tasmanian Bluegum (*E. globulus*).

Forest fuels in the south west available for planned burning accumulate rapidly as ground litter, dead trash and green scrub. Ground litter comprises fine surface fuels (leaves, twigs, buds, capsules) and in the karri forest a decomposing profile litter fuel layer of considerable depth (metres) to the soil basement.

At the commencement of spring both surface and profile litter fuels are fully saturated by winter rains. Depending on rainfall patterns, these fuel layers progressively dry-out during spring and summer. Surface litter fuels dry out at a greater rate than profile litter fuels. In a normal year jarrah forests are available for prescribed burning from October through to December inclusive. Karri forests, because of their deep moist profile fuels, are available for burning from late December to the end of April inclusive.

During the December to April period the 'window of opportunity' for southern karri prescribed burning is very limited. Research by DEC shows that planned burning in the karri forest is most effective when the prescribed amount of fuel removed occurs in a mosaic over about 60-70% of the forest area (Burrows 2008). In order to meet these burn objectives an exact combination of surface and profile fuel moisture and Fire Rate of Spread Index* must be met. *Fire Rate of Spread Index is the maximum rate of spread predicted from wind speed and surface moisture content for level topography, 60% crown cover and five year old fuels for each forest type.

Opportunities for planned burning are further constrained by wind direction, the need to burn during the stable periods of each weather cycle and meet acceptable air quality criteria; the availability of resources and the number of days required to complete burns and commitments to other prescribed burns and wildfires. In addition DEC does not undertake new planned burning during the Prohibited Burning Time in summer unless a special suspension approval has been received from the Fire and Emergency Services Authority (FESA).

Burn-offs on private lands

Private burning requires a "permit to burn", during the Restricted Burning Time, issued by the local authority, such as the Shire Council, for a specific purpose(s) and is approved for 28 days. Landholders and managers generally undertake prescribed burns to protect human life and property assets, but may undertake burns for other reasons including land clearing, waste reduction and to protect broader community assets.

The conflict in land use

Wildfires, burn-offs on private lands, karri forest burns and the smoke that these fires generate have the potential to clash with sensitive periods of grape development that may negatively affect wine grape and wine quality.

Research on the smoke effects on grapes and wine

For many years the exposure of wine grapes to smoke was thought to create smoke-like aromas and flavours in wine. Research commenced in 2003 when the Australian Wine Research Institute (AWRI) conducted initial investigations into the nature and amelioration of smoke-like flavours in grapes and wine caused by wildfire smoke (AWRI 2003). This investigation was in direct response to the 2003 wildfires in Victoria and New South Wales that created high density smoke exposure to vines for prolonged periods of time with the subsequent development of smoke-like aromas and flavours in wine. The result of this initial investigation provided largely qualitative evidence that grapes and wine can be made unfit for purpose from exposure to wildfire smoke. However a direct link between smoke exposure to grapes and the subsequent development of smoke-like aromas and flavours in wine was not established by published research until 2007 (Kennison et al. 2007).

Ongoing research, involving the direct and controlled application of smoke to field-grown grapevines, has been conducted in Western Australia from 2005 (Kennison et al. 2009a). This research demonstrated the direct link between smoke application to grapevines and the development of smoke taint in wine (Kennison et al. 2007; Kennison et al. 2008).

Wine sensory studies established perceivable differences between smoked and unsmoked wines. Wines produced from fruit exposed to smoke were described as exhibiting 'smoky', 'burnt', 'ash', 'ashtray', 'salami', 'smoked salmon', 'dirty', 'earthy' and 'smoked meat' characters (AWRI 2003; Kennison et al. 2007). None of these smoke-like aromas were detected in wines produced from unsmoked fruit during these studies. These studies also utilised scientific equipment for wine analysis of key phenolic compounds contained in smoke, such as guaiacol, that is known to have a 'smoky' aroma (Boidron et al. 1988). Similar compounds have also been detected in wines aged in toasted oak barrels (Boidron et al. 1988).

Studies have clearly demonstrated three distinct periods of grapevine sensitivity to the uptake of smoke-like compounds (Kennison 2009a, Kennison et al. 2009b). The first period is characterized by a low potential for grapevine smoke uptake and exists early in the growing season up to the period of flowering. The potential for smoke uptake is variable (low to medium) during the second period from when grape berries are pea size through to 3 days post veraison (grape softening and colour change). A high potential for the uptake of smoke compounds exists during the third identified period from 7 days post veraison through to harvest. Grape exposure to smoke therefore needs to be limited during periods of grapevine sensitivity.

Following grapevine exposure to smoke, smoke derived phenols have been found to increase throughout the winemaking process. The level of smoke aromas and flavours has also been shown to increase in the bottled wine over time (Kennison et al 2008). This research demonstrates the potential for underestimation of smoke taint in fruit and juice samples and requires further investigation.

Investigations have been conducted to ascertain if it is possible to reduce or ameliorate the smoke characteristics in wine made from smoke exposed fruit during and after the winemaking process. One recent study treated smoke effected wine by the use of reverse osmosis to reduce the intensity of smoke aromas in the final wine (Wilkinson 2009). Research is ongoing to investigate the reduction of smoke-like aromas throughout the winemaking process.

The research on the effects of smoke on grapes and wine is also continuing. Part of the planned future scientific research is to assist grape growers and winemakers reduce the severity of smoke exposure to grapes and wine. Investigations are continuing on preventative techniques during the grape growing season and amelioration techniques during the wine making process.

The other major component of future research is to assist grape growers, wine makers and generators of smoke to reduce the incidence of smoke on grapes and wine. The research is led by the Department of Agriculture and Food Western Australia (DAFWA) with extensive collaboration between researchers, industry and forest managers around Australia. The research aims to develop better planning and predictive systems for grape production and prescribed burning and will include development of decision support tools to identify 'windows of opportunity' for prescribed burns and burn-offs on private lands to avoid or minimise clashes with grape and wine production. This will involve modelling historical grape phenology data (veraison and harvest dates) and historical prescribed burn periods.

Comprehensive extension of research to vignerons in a form that can be practically implemented is a focus of this future project. This will include the development of written information and interactive information days (i.e. seminars, workshops and field days). This collaborative national project is being led by Western Australia.

Vineyard Mapping Project

Communication between the wine grape industry and forest industry is a key requirement in developing supportive relationships. Formal communications by DEC include pre-season regional stakeholder forums seeking input to the six-season indicative burn plan and annual burning programs, one-on-one liaison with individual grape and wine producers as required, and prescribed burn notices published in local newspapers and sent to all immediate neighbours. Prescribed burning plans have been amended and burns deferred as a result of this collaborative process.

Because smoke can travel across many property boundaries and to other regions the wine grape industry has requested that all growers in a region are informed before a planned burning on public or private lands proceeds. This sounds easy but not all wine grape growers can be contacted through their local wine grape associations so other contact networks need to be developed.

To address this issue a comprehensive vineyard mapping project commenced in September 2007. The project initiated by the Smoke Effect Working Group, is coordinated by DAFWA.

Properties containing grapes are identified by aerial photography. Information is then sent to the property owner of those grapevines to confirm details about the property, including up-to-date contact details of the property owner and manager, property boundary, grape planted area boundary and that the plants identified are in fact wine grapes. Information is also requested on wine grape varieties planted. The variety information is important in predicting the timing of grape development stages and may be required if future research identifies that varieties differ in their susceptibility to smoke. The information about individuals is confidential in nature and is used only for the purpose for which it was intended, which is for DEC burn plans and DAFWA's Client and Resource Information Database.

The information collected is then made available to DEC to assist with their Master Burn Planning (MBP) processes. The MBP is a decision support tool that integrates the factors necessary for developing DEC's six-season indicative and annual prescribed burn programs in forests, parks and reserves. This information assists DEC in their liaison with the wine industry of Western Australia regarding planned burns on public lands. Details regarding planned burns are made publicly available on the DEC website.

The Vineyard Mapping Project focused initially on the wine regions in the south west most closely associated with tall forests. Vineyard and grower data has been collected for the Manjimup, Pemberton and Margaret River wine regions. About 80% of the 451 properties identified in these three regions responded. The total wine grape planted area for those who responded is 6457 hectares. The information on the property owners who did not respond is also provided to DEC for their MBP but confirmation of details is unavailable.

The next wine regions to be surveyed are the Blackwood Valley and the Great Southern. It is planned to eventually map all of the vineyards in Western Australia. It should also be noted that the information collected dates very rapidly and requires constant maintenance.

DAFWA will provide wine region overview maps to DEC, WIAWA, relevant wine region associations, FESA and local Shires. Client confidentiality will ensure that no individual property information is contained on the maps. The overview maps will be extremely useful to identify the location of a wine grape property in relation to a planned burn on public land or burn-off on private land.

The vineyard mapping project has been extremely valuable in updating DAFWA's Client and Resource Information Database for the wine grape industry. This database is used for biosecurity purposes and most recent information is essential if a biosecurity issue occurs. This project has also increased wine grape industry client base details for the Premium Wine Grape Project within DAFWA.

Smoke effect working group

In response to the potential for conflict between prescribed burns and grape and wine production the Western Australian Wine Industry Association (WAWIA) moved to form a working group to progress solutions to the issue. The inaugural meeting of the Smoke Effect Working Group was held in September 2006.

This partnership between government and industry functions to:

- co-ordinate research into smoke effects on grapes and wine
- develop better planning and predictive systems for grape production and burning
- enhance stakeholder communication
- find amicable solutions to this issue

This group is chaired by the Wine Industry Association of WA (WIAWA) and has representation from the WIAWA, WA regional wine industry associations, DAFWA, DEC and Curtin University of Technology. FESA and local Shires have been invited to join the group so that the risks associated with burn-offs on local Shire and private lands and communication with owners can be addressed. Additional stakeholders are invited to join the group as they are identified.

The future

The research, planning and predictive work of the Smoke Effect Working Group has a strong focus on prevention and amelioration techniques for reducing the effect of smoke on grapes and wine.

The effect of smoke on grapes and wine was originally a very emotive issue. However, the willingness of all stakeholders to work together to find an amicable solution has shown that different land uses that are adjacent are possible.

Key learnings

Land use conflict is a common issue in many agricultural regions of Australia. These conflicts can be resolved such that all land users can live in harmony with:

- clear identification of the problem;
- open communication channels between stakeholders and;
- comprehensive sharing of all available information.

Acknowledgements

The authors would like to acknowledge the invaluable input from DEC for the review of the 'Prescribed burning on Department of Environment and Conservation managed lands' section of this paper; Associate Professor Mark Gibberd, Chair Viticulture and Oenology, Curtin University of Technology and Keith Pekin, Development Officer, WIAWA for the review of this paper. The authors would also like to acknowledge the Grape and Wine Research and Development Corporation (GWRDC) and the Australian Federal Government for funding much of the research.

References

- Australian Wine Research Institute 2003, *Annual Report 2003*, Glen Osmond, SA.
- Boidron JN, Chatonnet P and Pons M 1988, 'Influence du bois sur certaines substances odorantes des vins', *Connaissance de la Vigne et du Vin*, 22: 275-294.
- Burrows ND 2008, 'Linking fire ecology and fire management in south-west Australian landscapes', *Forest Ecology and Management*, 255: 2394-2406.
- Government of Western Australia 2008, Department of Environment and Conservation Annual Report 2007-2008, Appendix G Fire Management pp. 215.
- Kennison KR 2009a, 'Bushfire generated smoke taint in grapes and wine', Final report to Grape and Wine Research and Development Corporation, RD 05/02-3.
- Kennison KR, Wilkinson KL, Williams HG, Pollnitz AP and Gibberd MR 2009b, 'Smoke application to field-grown grapevines at key phenological growth stages affects the sensory and chemical properties of resultant wines', (manuscript in preparation).
- Kennison KR, Wilkinson KL, Williams HG, Smith JH and Gibberd MR 2007, 'Smoke-derived taint in wine: effect of postharvest smoke exposure of grapes on the chemical composition and sensory characteristics of wine', *Journal of Agricultural and Food Chemistry*, 55: 10897-10901.
- Kennison KR, Gibberd MR, Pollnitz AP and Wilkinson KL 2008, 'Smoke-derived taint in wine: the release of smoke-derived volatile phenols during fermentation of merlot juice following grapevine exposure to smoke', *Journal of Agricultural and Food Chemistry*, 56: 7379-7383.
- Wilkinson KL 2009, 'Amelioration of smoke derived taint in wine by membrane filtration and solid phase adsorption', Final report to Grape and Wine Research and Development Corporation, RD 06/04-2.